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REPLY TO
ENGINEERING OFFICE
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BOLTON, MA 01740
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September 23, 1997
BVY 97-119

United States Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

References: (a) License No. DPR-28 (Docket No. 50-271)
(b) Letter, VYNPC to USNRC, BVY 97-46, dated April 14, 1997
(b) Letter, USNRC to VYNPC, NVY 97-132, dated August 28, 1997

Subject: Response to NRC Request for Additional Information Regarding Report YAEC-1339 For Vermont Yankee Nuclear Power Station

In Reference (b) Vermont Yankee submitted, for NRC review and approval, YAEC-1339, "Yankee Atomic Electric Company Application of FIBWR2 Core Hydraulics Code to BWR Reload Analysis." Vermont Yankee intends to use FIBWR2, a new version of FIBWR, to validate reload analyses which include new fuel types with part length fuel rods and varied water tube designs.

In Reference (c) the NRC requested additional information regarding YAEC-1339. The NRC's questions and Vermont Yankee's responses are attached.

We trust that this submittal provides the requested information. However, should you have questions or require additional information, please contact this office.

Sincerely,

VERMONT YANKEE NUCLEAR POWER CORPORATION

James J. Duffy

James J. Duffy
Licensing Engineer

A001/1

Attachments: Response to Request for Additional Information
Figure 1

c: USNRC Region I Administrator
USNRC Project Manager - VYNPS
USNRC Resident Inspector - VYNPS

Response to NRC Request for Additional Information

Report YAEC-1339:
Application of FIBWR2 Core Hydraulics Code
to BWR Reload Analysis

Question 1
On page 4 of YAEC-1339, you stated that "FIBWR contains the vendor correlation." Please explain what correlations you plan to use with FIBWR2 and what verification analysis you have to perform with these correlations.

Response
FIBWR2 presently has the General Electric Nuclear Energy (GE) GEXL Plus correlation installed in it for determining the transient change in Critical Power Ratio (CPR). This correlation is applicable to GE fuel types. The correlation has been implemented in its exact form, which includes the form of the correlation and a set of coefficients specific to a particular fuel type. In the future Yankee Atomic plans to use the licensing basis fuel performance correlation for each fuel type in a reload core and may involve the installation of other vendors correlations.

The implementation of a new transient fuel performance correlation will involve two general steps to complete verification. This process ensures that both the correlation and the thermal hydraulic simulation from FIBWR used as input boundary conditions produce consistent results over the applicable range of the correlation. These are the same steps that have been followed to implement GEXL Plus in the current approved hot channel methodology (RETRAN/TCPYA01).

To support the verification, fuel vendor simulation data (code input and output) is used. Once the correlation is programmed into FIBWR2, vendor correlation input is used and test cases are run to determine if the FIBWR2 CPR output is the same as the vendor's output. The successful benchmark is the matching of the vendor test case output. The second step involves the benchmark of vendor simulation of CPR performance over a range of thermal hydraulic conditions associated with the correlation. The benchmark to this data demonstrates the correct CPR calculation for the applicable fuel type, that is, for a given fuel assembly pressure, active flow and power level, the FIBWR2 calculated CPR agrees well with the vendor data. This step also provides a second check that the fuel assembly input for FIBWR2 has been correctly calculated.

The two steps described above verify that the vendor fuel performance correlation is installed correctly in FIBWR2. The verification of the simulation of transient thermal hydraulic conditions used as input to the correlations are, in part, the subject of the FIBWR2 topical (YAEC-1339). The use of FIBWR2 to simulate the transient conditions would be unaffected by the installation of a new correlation.

Question 2

In Figure 3-4, (page 33 of YAEC-1339), why is the calculated void fraction higher than the analytical solution in the 2.0 to 2.5 second time frame of the flow oscillation transient?

Response

The FIBWR2 calculated void fraction for the oscillatory transient shown in Figure 3-4 is higher in the 2.0 to 2.5 second time frame due to the level of detail in the FIBWR2 model and the numerical methods employed in the code. The accuracy of any simulation with FIBWR2 is dependent on the nodalization detail because of inherent numerical diffusion. Similar numerical techniques exist in other transient thermal hydraulic codes. For the simulation of oscillatory conditions such as those shown in Figure 3-5, deviance from the analytical solution results with the 25 node model is not unexpected. The number of nodes available to represent the fluid void fraction do not provide sufficient axial resolution to represent the sharp axial variation in void predicted by the analytical solution. The consequence is that the axial variation in void, which should be sharp is instead smeared over a distance of at least the node height. In fact, since the wave has been swept up the channel, this smearing has occurred through several nodes.

The effect of nodalization detail and the consequences of numerical diffusion on simulation accuracy with FIBWR2 are shown in Figure 3-5 of the report and Figure 1 of this attachment. Figure 3-5 shows the same oscillatory simulation with 50 nodes and it provides a more accurate comparison to the analytical solution in the 2.0 to 2.5 second time frame. Figure 1 shows the same simulation with 25, 100 and 400 node FIBWR2 models. As shown, the 100 and 400 node models are increasingly more representative of the analytical solution.

The significance of the comparison to the analytical oscillatory solution, which represents an outside bound to the expected change in thermal hydraulic conditions, is the need to ensure sufficient nodalization detail is obtained for a transient simulation. If fuel performance predictions of oscillatory conditions were to be carried o. it is expected that 400 axial nodes may be required. In other parts of YAEC-1339, FIBWR benchmarks to analytical solutions representing a steady state condition and a flow decay are summarized. These comparisons were carried out with the FIBWR2 25 node model and show virtually identical results as the analytical solutions. In these cases a 25 node model is sufficient. For evaluation of transient thermal hydraulic performance, where conditions may change more rapidly than a flow decay but slower than the oscillatory condition, sensitivity studies are performed to ensure that the results are not altered by nodalization detail. Section 4.2 of YAEC-1339 describes such a sensitivity study that was carried out for the Critical Heat Flux experimental test data (16 rod test data). A 24 node model was proven to be adequate for representation of the steady state and transient test data. In the case of the transient hot channel performance evaluation, Section 5.0 describes comparisons of FIBWR2 (24 nodes) to the current approved method, RETRAN/TCPYA01, which used a 12 node model. The comparison of both subcooling and pressurization transient evaluations with this model showed excellent agreement. Based on the excellent agreement, it was concluded that 24 nodes was a sufficient level of detail for the FIBWR2 model.

Question 3

On page 35, of YAEC-1339 you stated that "FIBWR2 is structured to allow implementation of fuel vendor specific correlations." What corralations have already been implemented in your coding and what procedure will you use to verify any additional correlations you add to FIBWR2?

Response

We have implemented the GE correlations for the GE-9 and GE-13 fuel types. We have no current plans to add additional correlations. However, were we to use another correlation, the verification process would be similar to that described in our response to Question 1.

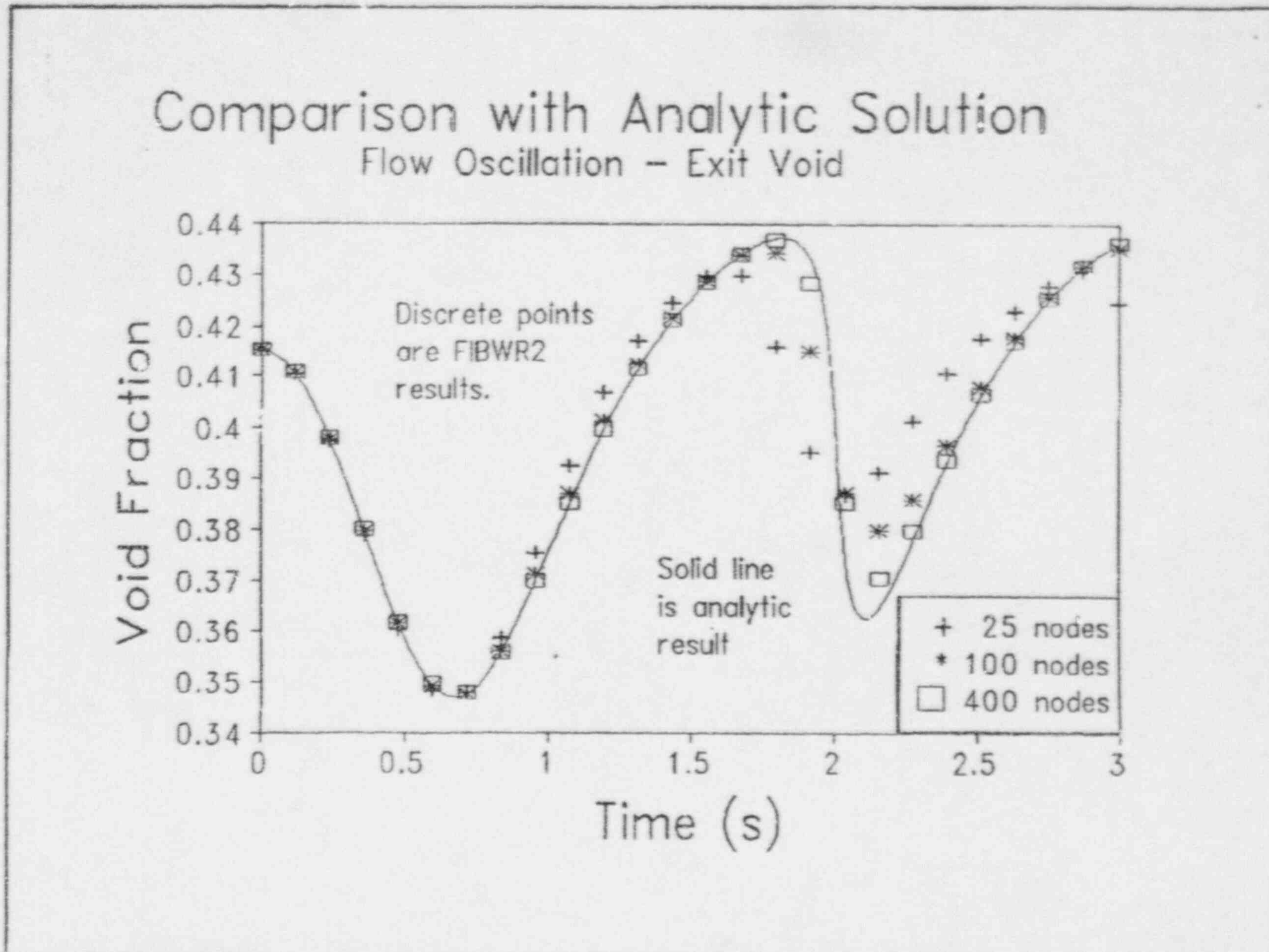
Comparison with Analytic Solution
Flow Oscillation - Exit Void
Void Fraction
0.44
0.43
0.42
0.41
0.4
0.39
0.38
0.37
0.36
0.35
0.34
Discrete points
are FIBWR2
results.
Solid line
is analytic
result
+ 25 nodes
* 100 nodes
□ 400 nodes
0
0.5
1
1.5
2
2.5
3
Time (s)

FIGURE 1